Stress, Mean Arterial Pressure, and Roll over Tests as a Predictor of Pregnancy Hypertension

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Abstract: All three of causes from the high maternal mortality rate (MMR) in Indonesia are bleeding, hypertension and infection. These three main causes have changed in proportion, where bleeding and infection tend to decrease while hypertension increases. Seeing a lot of research on stress, MAP and ROT associated with pregnancy hypertension, but there is no method to predict pregnancy hypertension, so done research on stress, MAP, ROTS as predictors of pregnancy hypertension. This research used a *cross sectional study* method. The research subjects consisted of 50 normal tension pregnant women and 50 hypertensions, according to inclusion and exclusion criteria. Data on characteristics, obstetric history and stress were measured using a standard questionnaire. MAP and ROT were measured 3 times (gestational age 27, 28 and 32 weeks. The results of the research concluded that stress, MAP and ROT are associated with the incidence of hypertension in pregnancy. Stress, MAP and ROT can be used as predictors of pregnancy hypertension (age of pregnancy 27 and 32 weeks).

1 INTRODUCTION

The main complications causing nearly 75% of maternal deaths are heavy bleeding, puerperal infections and high blood pressure during pregnancy. Globally, almost 99% of maternal deaths occur in developing countries. The ratio of maternal deaths in developing countries in 2015 was 239 per 100,000 live births versus 12 per 100,000 live births in developed countries, this is still far from the target of 2030 which is 70 per 100,000 live births (WHO, 2015)

Until now the maternal mortality rate (MMR) in Indonesia is still relatively high, which was recorded in 2012 of 359 per 100,000 live births. This figure is still far from the SDG's target in 2030 of 70 per 100,000 live births. The 3 main causes of high MMR in Indonesia are bleeding, hypertension and infection. Indonesia Health Profile data in 2015 shows hypertension is the second largest contributor to MMR and has increased from year to year, namely in 2012 (26.9%) and in 2013 (27.1%). These three main causes have changed in proportion, where bleeding and infection tend to decrease while hypertension increases (Kemenkes, 2016)

Hypertension is the most frequent medical complication in pregnancy (5-10% of pregnancy). About 30% of hypertension is caused by chronic hypertension and 70% is caused by pre-eclampsia - gertational hypertension. Understanding the disease process and its impact on pregnancy are the most important thing, because hypertension is still a major cause of maternal and perinatal morbidity and mortality worldwide. Complication that occur in the mother can include placental abruption, Disseminated Intravascular Coagulopathy (DIC), eclampsia, kidney failure, bleeding or liver failure, intracerebral hemorrhage, hypersensitive enceopathy, pulmonary edema and death. Meanwhile, complications that occur in the fetus and neonatal include retardation of severe intra-uterine growth retardation, oligohdroamnion, preterm labor, hypoxia-acidosis, neurological disorders and death (sabaruddin dkk, 2015)

In pregnancy, there is an invasion of trophoblasts into the muscle layer of the spiral arteries which causes degeneration of the muscle layers so that distention and vasodilation of the spiral arteries will result in decreased blood pressure, decreased vascular resistance and increased blood flow to the utero placenta. As a result, blood flow to the fetus is quite

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a lot and tissue perfusion also increases so as to ensure proper growth of the fetus. This process is called spiraling artery remodeling (Perry, H. *et al, /*2018)

In PE / E remodeling failure occurs which will cause the spiral arteries to become stiff and hard so that they do not experience distension and vasodilation so that blood flow to the utero placenta decreases and there is ischemia and placental hypoxia. The impact of placental ischemia will cause changes that can cause hypertension in pregnancy. The mean diameter of the spiral arteries in normal pregnancy is 500 microns while in preeclampsia 200 microns (Peres, G., *et al,* 2018)

High stress, anxiety or depression directly or indirectly affect pregnancy and can cause hypertension in pregnancy. Stress changes the hypothalamus - pituitary-adrenal (HPA) caused an increase in cortisol and associated cellular immune changes (Vianna, P. *et al,* 2011)

Taslim's research, et al (2016) explained that stressed pregnant women will experience Grade 2 hypertension by 28.6% and there are no pregnant women with stress respondent conditions in the incidence of Grade 2 hypertension and no pregnant women who experience stress have Grade 1 hypertension. Nasr et al (2016) also support the previous findings, that there is a significant correlation between depression and stress levels and the level of education of women with hypertension in pregnancy. These findings are in line with the theory of anxiety / stress where stress can increase cortisol, epinephrine & other steroids, so blood to the kidneys decreases so renin production increases. Renin will stimulate the formation of angiotensin I then turn into angiotension II, then in turn stimulates aldosterone secretion by the adrenal cortex. So that sodium and water retention occurs in the kidney tubules, the intra-vascular volume will increase, hypertension occurs. Vianna et al (2011) in their medical hypothesis also say the same thing that ongoing anxiety changes the hypothalamus through the pituitary to govern adrenal (HPA) secreting the hormone cortisol, the release of this hormone causes a decrease in the sensitivity of glucocorticoit dexamethasone (DEX) anxiety so that cellular immunitybecomes changed so preeclampsia occurs and can even have an effect until postpartum (Vianna, P. *et al,* 2011)

Mean aerteril pressure (MAP) is the average value of arterial pressure which is assessed by measuring the pressure of diastole and systole and then calculated using the MAP formula. MAP is said to be positive if the result is> 90 mmHg and negative if the result is <90 mmHg (Suprihatin, E. and Norontoko, D. A, 2015)

Kenny et al (2014) in their research found a method to predict the incidence of hypertension in pregnant women using measurement of mean arterial pressure (MAP), and the results showed that in pregnant women with preeclampsia the MAP value was higher compared to pregnant women with normal tension (Kenny, L. C. *et al,* 2014) Likewise with Akoleker (2012) in his research explained that there is a linear correlation between Mean Arterial Pressure (MAP) with preeclampsia. Taslim et al (2016) also got the same research results where MAP was significantly associated with hypertension in pregnancy and abnormal MAP is 11.69 times the risk of hypertension in pregnancy.

In general, pregnant mother will experience physiological hematological change. Where there is a profound effect between the mother's position on the hemodynamic profile in the mother and fetus. In the supine position the pressure from the inferior vena cava (VCI) causes a decrease in venous return to the heart and results in decreased stroke volume and cardiac output. Turning from lateral to supine position can result in a decrease in cardiac output by 25%, causing disruption of uteroplacental blood flow (Sherwood, 2014). Disruption of uteroplacental flow causes changes in the value of the hemodynamic profile between mother and fetus as blood pressure rises (Sherwood, L, 2014)

Roll Over Test (ROT in Figure 1 is a measurement of blood pressure in two different positions, namely in the left side sleeping position and the supine sleeping position. ROT is said to be positive if there is a change / increase in diastolic blood pressure between the side and supine sleeping position ≥ 15 mmHg and negative when changes in diastole <15 mmHg (Suprihatin, E. and Norontoko, D. A, 2015)

Ghojazedeh et al (2013) in their research found a new method using roll over test (ROT) measurements, and the results showed that significantly positive ROT values were higher in the preeclampsia pregnant women group.[9] In accordance with Walia's findings et al (2015) where ROT values of more than 15 mmHg in normal pregnant women are 2.191 times more likely to develop preeclampsia (Kaytri, S, 2016)

The high mortality and morbidity of mothers and babies due to complications caused by hypertension in pregnancy, was an indication of the importance of finding a method that can be accurately to predict of hypertension in pregnancy so that complications can be prevented as early as possible. Until now, no predictor has been found that matches the required standard. Seeing the many studies on stress, MAP and ROT associated with hypertension in pregnancy, but

there have never been researchers who tried to combine these three variables as predictors of hypertension in pregnancy so it is important to examine whether the combination of stress, MAP, and ROT is able to be a predictor of hypertension in pregnancy (Walia, M., D, A. S. and Gupta, G, 2015)

2 METHODS

This research was conducted at the Grandmed Lubuk Pakam General Hospital. The Respondents in this research were divided into 2 groups, namely the group of normal tension pregnant women by 50 people and hypertensive pregnant women by 50 people. The sampling technique used accidental sampling where patients who happened to come to do a pregnancy examination at the time of the study at the study site will be included in the study sample adjusted to the inclusion and exclusion criteria.

This research is a hybrid type with a cross sectional design and prospective cohort. Stress, MAP and ROT assessments of normal pregnant mother with tension and hypertension were measured at the same time. MAP and ROT were measured 3 times, namely 27, 28 and 32 weeks gestational age in normal tension and hypertensive mothers in pregnancy.

Instrument A is an instrument used to measure anxiety of pregnant women using a standardized questionnaire that is the Kessler Psychological Sitress Scale (K10) by Kessler R. Professor of Health Care Policy from Harvard Medical School Boston USA which consists of 10 questions about anxiety and depression symptoms experienced by a person in the last 4 weeks of pregnancy to see a measure of stress. Stress intensity is measured using ratio data.

Instrument B is a tension gauge which is a spignomanometer to measure MAP and ROT. MAP and ROT intensity was measured using millimeter mercury (mmHg) ratio data.

MAP measurement work procedures is make sure the pregnant mother is relaxed, backs leaned, feet should be comfortable and step on the floor, Make sure the sphygmomanometer number is visible, and the examiner's position must also be comfortable, Attach a cuff to the left arm of a pregnant mother with a pipe parallel to the brachial artery. Ensure that the pulse is in the brachial artery and start pumping until the pulse is not palpable and mark the pressure obtained. Put down the stethoscope bell above the brachial artery. Turn the valve clockwise, until the valve on the rubber pump is tightly closed. The cuff is pumped to a pressure of 30 mmHg until the brachial artery pulses are no longer palpated. Next slowly rotate the rubber pumping balloon valve and listen for systolic and diastolic pressure.

Record the results and calculate the MAP value using the formula: MAP = [Pressure System + 2 (Diastole)]: 3ROT measurement work procedures. Let the pregnant mother to get into bed and direct the mother to sleep on her left side and relax for 15 minutes. Ensuring that sphygmomanometer numbers are visible and the examiner's position must also be comfortable. Attach a cuff to the left arm of a pregnant woman with a pipe parallel to the brachial artery. Ensure that the pulse is in the brachial artery and start pumping until the pulse is not palpable and mark the pressure obtained. Put down the stethoscope bell above the brachial artery. Turn the valve clockwise, until the valve on the rubber pump is tightly closed. The cuff is pumped to a pressure of 30 mmHg until the brachial artery pulses are no longer palpated. Next slowly rotate the rubber pumping balloon valve and listen for systolic and diastolic pressure.

Record the results of the left tilted blood pressure measurement. Let pregnant women to change sleeping position to the supine position and be relaxed for 15 minutes. Ensure that the pulse is in the brachial artery and start pumping until the pulse is not palpable and mark the pressure obtained. Put down the stethoscope bell above the brachial artery. Turn the valve clockwise, until the valve on the rubber pump is tightly closed. The cuff is pumped to a pressure of 30 mmHg until the brachial artery pulses are no longer palpated. Next slowly rotate the rubber pumping balloon valve and listen for systolic and diastolic pressure. Invite and accompany the mother to get down from the bed. Recording supine blood pressure measurement results.. Calculate and record the diastole blood pressure difference in the left tilt position with supine position.

Data collection was carried out after obtaining permission from the research location and the Research Ethics Commission.

The researcher met with related parties at the research location through the following procedure. Determine the subject based on inclusion and exclusion criteria. Introduce yourself and explain research covering the objectives, rights and obligations of the subject as well as the benefits of research to the subject. Provide an informed consent sheet to be signed by the subject, if the subject is willing to participate in the study. Explained the procedure of the series of checks to be carried out. Measuring the blood pressure of the subject by using the *spigmomanometer* 3 times, ie when in a sitting position, sleep on your left side after that 15 minutes later when the supine sleep position. Conduct direct

interviews related to stress experienced by the subject. Enter into a repeat examination meeting contract and conduct MAP and ROT examinations at 28 and 32 weeks' gestation. Record all data on the observation sheets. Data processing is carried out with the SPSS (Statistical Product and Service) program through the stages of editing, coding, data entry, data cleaning.

This analysis described the data in the form of a categorical table. The data which have processed will be presented in tabular and narrative form. The Data that have been got by *cross sectional* and prospective cohort used *Chi-Square* test analysis to see the relationship of stress, MAP and ROT with pregnancy hypertension. The strength of the data relationship obtained by cross sectional is known based on the calculation of the association size of the Odds Ratio (OR) and the strength of the data relationship obtained through the prospective cohort approach is known based on the calculation of Relative Risk (RR). If OR / RR is equal to 1 it means that there is no relationship between the independent variable and the dependent variable. If OR / RR is more than 1, it means that there is a relationship between the independent variable and the dependent risk factor. If OR / RR is smaller than 1, it means that there is a relationship between the independent variable and the dependent dependent which is protective for the effect. In addition to the OR / RR value, we also pay attention to the value of the confidence interval (CI) and the p-value. If CI accross number 1, the OR / RR value is not significant.

3 RESULT AND DISCUSSIONS

Figure 1 showed that based on work status, education, age, household income, wife's salary, husband's salary, household members, home ownership status, history of abortion, parity of pregnancy plans and pregnancy spacing there were no significant differences between groups of normal pregnant women with the hypertension group in pregnancy as seen from the frequency distribution graph based on the characteristics of the respondents. So it can be concluded that the study sample was normally distributed and was homogeneous.

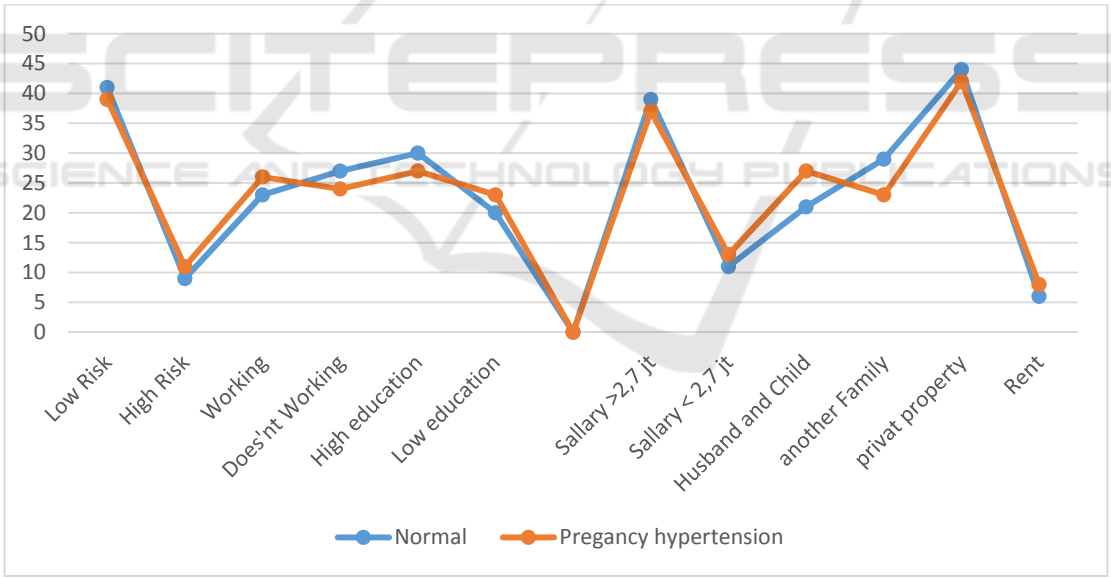

Figure 1: Frequency distribution based on respondent Characteristics.

Table 1 showed a significant difference in the history of preeclampsia and eclampsia with a value of p = 0.001; OR = 10,286; 95% CI 2,209-47,9. That is, pregnant women who have a history of PE / E have a tendency to experience hypertension at 27 weeks gestation by 10 times compared to pregnant women who have no history of PE / E.

Table 1: The relationship of obstetric history with hypertension at 27 weeks gestation.

Variable	Normal		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
PE History						
Doesn't exist	47	56,6	36	43,4	0,001	10,286 (2,209–47,901)
There's	3	17,6	14	82,4		
Abortion History						
No	44	51,8	41	48,2	0,575	1,61 (0,527 – 4,920)
There's	6	40	9	60		
Paritas						
Primi	17	47,2	19	52,8	0,835	0,841 (0,371 – 1,904)
Multi	33	51,6	31	48,4		
Planning of pregnant						
Yes	44	48,9	46	51,1	0,739	0,638 (0,168 – 2,413)
No	6	60	4	40		
Pregnancy Distance						
≥ 24 Months	40	47,6	44	52,4	0,413	0,545 (0,182 – 1,637)
< 24 Months	10	62,5	6	37,5		

Based on the analysis of the data, the researchers concluded that although a history of abortion, parity, pregnancy planning and pregnancy spacing does not have an influence or relationship to the incidence of hypertension in pregnancy, but if the pregnant woman has a history of preeclampsia / eclampsia, it is likely that the mother will fall into a condition of hypertension in her pregnancy. Table 2 showed a significant difference in the history of preeclampsia and eclampsia with a value of p = 0.026; RR = 1,667; 95% CI 1,223-2,272. That is, pregnant women who have a history of PE / E have a tendency to experience hypertension at 32 weeks gestation by 2 times compared to pregnant women who have no history of PE / E.

Table 2. Analysis of the relationship of obstetric history with the incidence of hypertension at 32 weeks gestation.

Variabel	Normal		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
No History PE	42	50,6	41	49,4	0,026	1,667 (1,223 – 2,272)
Exist	3	17,6	14	82,4		
History of Abortion						
No	34	43	45	57	0,604	0,836 (0,513 – 1,362)
Exist	11	52,4	10	47,6		
Parity						
Primi	17	47,2	19	52,8	0,900	1,066 (0,731 – 1,554)
Multi	28	43,8	36	56,3		
Pregnancy plan						
Yes	39	43,3	51	56,7	0,503	0,706 (0,323 – 1,54)
No	6	60	4	40		
Pregnancy Distance						
≥ 24 Months	34	40,5	50	59,5	0,503	0,525 (0,249–1,109)
< 24Months	11	68,8	5	31,3		

Table 3 showed that minor stress has a statistically significant relationship between the normal tension group and the hypertension group at 27 weeks' gestation. Pregnant women who got experience minor stress have a tendency to experience hypertension by 4 times compared to pregnant women who are not stressed. This is because psychological stress can activate the hypothalamic-pituitary adrenal (HPA) axis, which in turn will increase corticosteroid and ketocolamin levels in the blood, this hormone will suppress the production of the adrenal glands and cause vasoconstriction of blood vessels. In this analysis just normal and minor stress categories which tested, because there were no samples that experienced moderate or severe stress (scores above 25).

Table 3: Relationship between stress and the incidence of hypertension at 27 weeks gestation.

Category	Normal Tension		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
Normal	39	62,9	23	37,1	0,000	4,162 (1,744-9,935)
Minor Stress	11	28,9	27	71,1		

Table 4 showed that mild stress has a statistically significant relationship between the normal tension group and the hypertension group at 32 weeks' gestation. Pregnant women who got experience minor stress have a tendency to experience hypertension at 32 weeks gestation by 2 times compared to pregnant women who are not stressed.

Table 4: Relationship of Stress with the incidence of hypertension at 32 weeks gestation.

Category	Normal Tension		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
Normal	37	59,7	25	40,3	0,001	1,958 (1,387 – 2,763)
Minor Stress	8	21,1	30	78,9		

Table 5 showed that mean arterial pressure statistically has a significant relationship between the normal tension group and the hypertension group at 27 weeks gestation.

Pregnant women with positive MAP have a tendency to experience hypertension by 3 times compared to pregnant women with negative MAP. Similar with the research of Chan et al (2017) in his study involving 12,915 women (326 of gestational hypertension and 82 preeclampsia) found the results that MAP trimester 1 and characteristics of pregnant women were able to be predictors of gestational hypertension and preeclampsia with a detection rate of 76%.

Table 5: Relationship of MAP with the incidence of hypertension at 27 weeks gestation.

Category	Normal Tension		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
Negative	29	100	0	0	0,001	3,381 (2,361-4,841)
Positive	21	29,6	50	70,4		

Table 6 showed that MAP as statistically has a significant relationship between the normal tension group and the hypertension group at 32 weeks' gestation. Pregnant women with a positive at 27 weeks gestation with MAP and a positive at 28 weeks gestation are more likely to have hypertension at 32 weeks gestation by 2 times and 3 times compared to pregnant women with a negative at 27 weeks gestation with MAP and a negative at 28 weeks gestation with MAP. Pregnant women with MAP at 32 weeks of gestation are positive also have a tendency to experience hypertension as much as compared to pregnant women. Kuc et al (2013) also found the results of a study that MAP is effective in predicting preeclampsia in the early trimester of pregnancy and resulting in a high rate of detection (72%). Similar with the findings of Nokele et al (2014) that MAP values were higher in preeclampsia women than those who did not.

Table 6: Relationship of MAP with the incident of hypertension at 32 weeks gestation.

Variabel	Normal Tension		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
MAP 27 Week						
Negative	20	69	9	31	0,004	2,088 (1,182 – 3,688)
Positive	25	35,2	46	64,8		
MAP 28 week						
Negative	16	76,2	5	23,8	0,003	2,658 (1,215 – 5,818)
Positive	29	36,7	50	63,3		
MAP 32 week						
Negative	14	100	0	0	0,001	0,360 (0,272– 0,478)
Positive	31	36	55	64		

Table 7 showed that the roll over test statistically has a significant relationship between the normal tension group and the hypertension group at 27 weeks' gestation. Pregnant women with positive ROT have a tendency to experience hypertension in pregnancy by 20 times compared to pregnant women with negative ROT.

Table 7: Relationship of ROT with the incident of hypertension at 27 weeks gestation.

Category	Normal Tension		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
Negative	47	68,1	22	31,9	0,001	19,939 (5,468-72,714)
Positive	3	9,7	28	90,3		

Table 8 showed that the roll over test statistically has a significant relationship between the normal tension group and the hypertension group at 32 weeks' gestation. Pregnant women with a positive ROT at 27 weeks gestation and a positive ROT at 28 weeks gestation are at risk of having hypertension in pregnancy by 2 times and 3 times compared to pregnant women with a negative ROT at 27 and 28 weeks gestation. Seen from pregnant women who have a positive ROT at 32 weeks gestational age tend to experience hypertension 98 times compared to pregnant women who have a negative ROT.

Table 8: Relationship of ROT with the incident of hypertension at 32 weeks gestation.

Variabel	Normal Tension		Hypertension		*P*	OR (95% CI)
	N	(%)	N	(%)		
ROT 27 week						
Negative	40	58	29	42	0,001	1,996 (1,453 – 2,740)
Positive	5	16,1	26	83,9		
ROT 28 week						
Negative	39	72,2	15	27,8	0,001	3,13 (2,007 – 4,882)
Positive	6	13	40	87		
ROT 32 week						
Negative	44	72,1	17	27,9	0,001	98,353 (12,498 – 773,965)
Positive	1	2,6	38	97,4		

There is a profound effect between maternal position on the hemodynamic profile in the mother and fetus. In the supine position the pressure from the *Vena Cava Inferior* (VCI) causes a decrease in venous return to the heart and results in decreased stroke volume and cardiac output. Turned around from lateral to supine position can result in a decrease in cardiac output by 25%, causing disruption of uteroplacental blood flow (Sherwood, 2014)

4 CONCLUSION

The results of the research concluded that stress, MAP and ROT are associated with the incidence of hypertension in pregnancy. Stress, MAP and ROT can be used as predictors of pregnancy hypertension (gestational ages 27 and 32 weeks).

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